



RCA INSTITUTES

INC.
formerly
MARCONI INSTITUTE
Founded 1909



FOREWORD — INTRODUCTION TO RADIO.

On November 2, 1920 radio station KDKA "went on the air" at East Pittsburgh, Pennsylvania — the first broadcast station in the world to feature regular broadcast programs. For the following seven years, or from 1920 until 1927, the radio industry passed through what was probably its most critical period of development. Industrial charts showed that more than twice as many radio sets, tubes and parts were sold in the three years from 1927 to 1930 than in the previous seven years from 1920 to 1927. Why was this so? Largely because people began to believe in radio. During the earlier years of radio broadcasting the average person had very little faith in this new form of entertainment; he considered radio to be merely a hobby for a leisure class of individuals who wanted a new plaything.

People were as skeptical about radio as they always have been about most everything entirely new. When Fulton invented the steamboat it was known as "Fulton's Folly". When the Wright brothers were laboring in the development of airplanes they were considered foolish and queer individuals. Henry Ford experienced tremendous difficulty in obtaining sufficient financial backing to build his horseless carriages — those who did invest a few hundred dollars with him were made independently wealthy years later.

Not so many years ago the backers of the telephone were in urgent need of capital, and telephone stock that was purchased at that time for a few dollars is today worth a fortune. And in radio we have similar conditions. The stock of one of the leading American radio companies recently increased from a little over thirty dollars a share to more than five hundred dollars a share in a period of two years.

Several years ago the following article appeared in a prominent Boston newspaper: "A man about 46 years of age, giving the name of Joshua Coppersmith, has been arrested in New York for attempting to extort funds from ignorant and superstitious people by exhibiting a device which he says will convey the human voice any distance over metallic wires so that it will be heard by the listener at the other end. He calls the instrument a telephone which is obviously intended to imitate the word telegraph and win the confidence of those who know of the success of the latter instrument without understanding the principles upon which it is based. Well informed people know that it is impossible to transmit the human voice over wires as may be done with dots and dashes and signals of the Morse code, and that, were it possible to do so, the thing would be of no practical value. The authorities who apprehended this criminal are to be congratulated and it is hoped that his punishment will be prompt and fitting, that it may serve as an example to other conscienceless schemers who enrich themselves at the expense of their fellow creatures".

It is fortunate that Marconi did not live in that period of ignorance before he carried out his dream of spanning the Atlantic Ocean by Wireless; this achievement of Marconi's in the year 1901, is considered to be one of the greatest wonders of science. Without his great discovery there is a possibility that present day radio communication would be impossible.

So that you may get a better and more comprehensive idea of the progress of radio we have classified the various stages of its development into three periods, beginning with the records of the early experimenters.

EVENTS DURING THE FIRST PERIOD.

Throughout the first period, from 1600 to 1895, the records are quite brief and widely scattered. Undoubtedly many valuable contributions were made to radio science by early experimenters whose identity will always remain unknown. In 1660, Roger Bacon, an English scientist, experimented with a circular alphabet placed on a pair of magnetic compasses, expecting that one compass might be controlled by the other for the purpose of communicating between two separated points. This idea, however, was not successful because the inventor was not aware of the fact that the earth's magnetic influences fixed the position of the compass needles. Since the theory of current and electricity were unknown during Bacon's time his experiments with magnetic compasses also proved a failure. However, these investigations by scientists more than three hundred years ago proves to us that even at that early date they were striving to find a way to communicate between distant points without the aid of intervening wires or metals. These experimenters realized that there was some means unknown to them by which intelligence could be conveyed through space, without the use of an actual physical conducting medium between points of transmission and reception.

The development of devices capable of producing frictional electricity occupied the attention of early scientists, and in 1672 Von Guericke invented a friction machine consisting of a globe of sulphur mounted on an axle which was revolved with a crank. By holding his hand against the revolving globe Von Guericke found that electrical charges were produced and retained upon the surface of the globe. The "charged" globe possessed the property of attracting light objects, such as bits of paper and cloth.

Later, about the year 1710, another experimenter substituted a circular flat glass plate in place of the globe of sulphur and produced frictional or "static" electricity by lightly pressing a cushion of cloth against the glass plate.

In 1719 Professor Cundens of Leyden succeeded in making a simple device for "bottling up" an electrical charge. This discovery was, in reality, the birth of the "condenser" — this is the name given to a device used to store up energy in electrostatic form. (Some authorities state that Musschenbroek, a German professor of philosophy and mathematics, was the first to achieve this distinction.)

Benjamin Franklin performed many electrical experiments during the early part of the eighteenth century. His investigations resulted in the formulation of the basic electrical law which states that "bodies charged with

electricity of like kind repel each other and those charged with unlike kind attract each other". Franklin believed that lightning was nothing more or less than static electricity and in 1850 he wrote a letter to the Royal Society of London expressing his opinion that "electricity might be drawn silently out of a cloud before it came nigh enough to strike". This belief of Franklin's received but slight recognition. However, when he later proved his theory by means of a long wire suspended in the air (one end of the wire was secured near the ground and the other raised to a considerable height by a kite) he was greatly acclaimed and made a Fellow of the Royal Society of London.

Now, who would ever imagine that frogs' legs could be utilized in the electrical field? Yet, from about 1780 to 1830, they were used in such large quantities that at times the demand often exceeded the supply. It is related that in the year 1780 the wife of Galvani, an experimenter, when preparing supper for a group of scientists accidentally touched a certain nerve in the leg of a frog, when at the same moment one of the scientists was experimenting with a nearby static machine. They were all amazed at seeing the frog's leg jump and kick as though it were really alive. After that incident frogs' legs were in demand for electrical experimentation and for many years thereafter they were used as storm indicators. An approaching electrical storm could be forecasted because the leg would twitch and struggle.

And now we come to the birth of the storage battery. In 1780, an Italian scientist named Volta, discovered a way of producing electricity by means of a device consisting of zinc and copper plates between which were placed moistened pieces of cardboard. An electrical pressure (voltage) was generated by the device due to the chemical action of the wet cardboard upon the zinc and copper plates and this pressure, or electromotive force, was utilized to set up a flow of current in a circuit connected to the plates.

The theory relating to the flow of an oscillatory current was expounded by Joseph Henry, an American, in 1820. He found that an oscillating current was produced when a condenser discharged through a coil of wire. An oscillating current is an alternating current that flows with great rapidity back and forth through a conductive path or medium.

Professor Savory in 1827 discovered that when a condenser discharged, some of its energy was actually projected outward into space. He noticed that a needle would become magnetized when placed in the vicinity of a discharging condenser. This discovery gave considerable encouragement to scientists and they put forth their most conscientious efforts to find a means of transmitting intelligence without the aid of wires.

Probably one of the most important of all discoveries in electricity was made by Faraday in 1831 — this was the principle of electromagnetic induction. Faraday found that if a current of electricity was made to flow intermittently in a wire, by opening and closing a circuit, this action would produce an electric current in a neighboring circuit not directly connected to the circuit in which the intermittent current was flowing.

Later, in 1851, Faraday discovered the principle of the electric motor. He found that if a conductor (a loop of wire) was free to move about its axis, and if it was placed near the poles of a magnet, the loop of wire would

rotate when an electrical current passed through it. This result clearly indicated that the reaction between the magnetic field set up at the poles of a magnet and the magnetic field about a current carrying conductor could be made to produce mechanical motion.

A few years after this discovery Faraday invented and constructed apparatus for generating electricity and also invented and developed the "induction coil". This device makes it possible to obtain a transformation of electrical energy from one circuit to another. He also labored incessantly on his idea that the space surrounding our earth could be utilized as a medium for conveying electromagnetic energy without the aid of wires.

About this time Maxwell brought forth many astounding theories on electrical phenomena, chief among which was the one in regard to electromagnetic waves. By mathematical deduction Maxwell predicted that electrical discharges propagated effects through space in the form of electromagnetic waves, thus setting up a disturbance that could be detected with suitable equipment at some distant point.

In 1842 it was recorded that Morse, the inventor of wire telegraphy, succeeded in sending messages short distances without the aid of wires. Then there came a succession of well-known scientific investigators; Dr. O'Shaughnessy in 1849, Professor Highton in 1872, Professor Trowbridge in 1880 and Professor Dolbear in 1882, all of whom utilized Faraday's principles and were successful in communicating short distances by wireless.

Heinrich Hertz, a German, confirmed Maxwell's theory concerning electromagnetic waves. Furthermore, he proved that these waves penetrated through insulators and metals of all kinds, including iron and steel, and that they were capable of reflection and refraction, and that their length could be measured. It should be borne in mind that radio waves and electromagnetic waves are one and the same thing. They are often called "Hertzian waves" in honor of Hertz.

Professor Branly, of the Catholic University of Paris, made a notable contribution to radio science between the years 1890 to 1892 by perfecting a small device, called a "coherer", to detect the presence of electromagnetic waves. While the coherer could not compare in efficiency with the present day vacuum tube as a detector, nevertheless, the device was enthusiastically received, and served as a material step forward in the art of radio during its pioneer days. The coherer consisted of a glass tube containing metallic filings which formed a loose electrical connection between two electrodes. Electric discharges in the vicinity of the coherer, or radio signals conveyed to it by means of a suitable wire antenna, would cause the filings to cling together and thereby pass an electric current which actuated a telephone head-set, causing the latter to produce sound. Thus, by employing both the coherer and the telephones the detection of electromagnetic waves was made possible.

Up to this point we have covered briefly the first period in the development of radio.

THE SECOND PERIOD INCLUDES EVENTS OF IMPORTANCE FROM 1895 to 1917.

Guglielmo Marconi, an Italian, became seriously interested in wireless communication at the age of eighteen and in 1896 he conducted experiments for the British government. Before actually becoming engaged in his work Marconi sought to familiarize himself with the activities of earlier scientists in this new field of communication, and after reading exhaustively about this subject he concluded that the theory developed by Heinrich Hertz was correct. After innumerable tests and demonstrations Marconi finally sent and received wireless messages over a distance of one and three-quarter miles.

Marconi, perhaps more than anyone else, was responsible for taking radio out of the experimental class and placing it on a practical footing. There is no doubt but that he made radio a commercial practicability. He conceived the idea of elevating wires a considerable height in the air to serve as an "antenna". Then by means of a single wire the elevated portion was connected to one side of the radio apparatus and another wire was used to connect the opposite side of the apparatus to the ground. The lowest extremity of the latter connecting wire was buried in the earth several feet and it became known as the "grounded end" of the antenna system. After adding these features to both transmitting and receiving equipment, in use at the time, he noticed that in the case of a transmitter the radiated signal energy would carry great distances for a given power and, also, the received signal heard in the telephones was much louder than that ever obtained in previous tests. In other words, these improvements made it possible to generate more powerful electromagnetic waves with a transmitter and to intercept more signal energy with the receiving apparatus. Also, it should be mentioned that Marconi materially improved the coherer by adding silver and mercury with metallic filings and sealing these in an exhausted sealed glass tube. Through the use of the improved coherer, relay, ink recorder and decoherer, he was able to receive signals when transmitted at speeds up to as high as 15 words per minute.

From 1896 until 1901 rapid advancements were made in the design of radio apparatus and the method of installation. Therefore, in February 1901, under conditions more favorable than in the past, Marconi established communication between Niton Station, Isle of Wight, and another station on the Lizard — a distance of 196 miles. After these remarkable achievements he planned to span the Atlantic Ocean by wireless and, accordingly, in the early winter of 1901 he sailed from Europe with his associates in this enterprise, and soon they arrived in Canada for the memorable event that was yet to come.

Mr. Marconi, assisted by Mr. Paget and Mr. Kemp, actually began the construction of their trans-Atlantic receiving station on December 6, 1901 in an old barracks building located at Signal Hill, St. Johns, New Foundland. They encountered their greatest difficulties in their attempts to erect a satisfactory antenna system. They tried many schemes with practically no success, employing balloons of various types to raise the receiving antenna to a suitable height, until finally they built a special kite that was powerful enough to hold the upper end of the antenna at an elevation of approximately 400 feet.

Before leaving England, Marconi supervised the erection of the trans-

Atlantic station located at Poldhu. After the receiving station at Signal Hill was in readiness the operators at Poldhu were notified by cable to start transmitting the letter "S" at fixed intervals during the day. Shortly after noon on December 12, 1901 the three dots of the letter "S" were distinctly heard by Marconi and his assistant, Mr. Kemp. This outstanding event furnished the material for one of the most brilliant pages ever written down in radio history. However, when news of Marconi's achievement was spread throughout the civilized world, many scientists refused to believe that such a feat had been accomplished and they were not convinced until Marconi himself confirmed it several days later. Marconi was richly rewarded for his industry, perseverance and faith in his project. In fact, these three qualities in any man invariably spells success.

In 1901 the Marconi Wireless Telegraph Company of America was established and in 1903 the deForest Wireless Telegraph Company of America was formed. A little later the United Wireless Telegraph Company was organized which absorbed the deForest Company in 1907. The developments during this particular time were confined mainly to improvement in the design of receivers and transmitters to increase their efficiency. About this time Professor Fessenden invented the electrolytic detector which consisted of a small platinum point placed in contact with an alkaline solution. Shortly after the discovery of this new type of detector General Dunwoody and G.W. Pickard began experimenting with the use of minerals for the same purpose and they found that galena, silicon, zincite and other minerals made very sensitive detectors of radio signals.

Then, a little later, Fessenden developed apparatus which produced the "spark" form of transmission; the "spark transmitter" became the standard type of equipment from that time on until within the last several years. Because of the interference which its signals set up under modern traffic conditions, the spark transmitter is being rapidly replaced by the vacuum tube transmitter. As a matter of fact, installation of the spark type of equipment is now prohibited by an act of the International Radiotelegraphic Convention which met at Washington in 1927. This Convention ruled that "no spark transmitter shall hereafter be installed and that all equipment of this type now installed shall be replaced not later than 1940". Undoubtedly, the various governments anticipate that the spark transmitter will be employed for several more years to come because they continue to ask questions on spark equipment in the examinations given to applicants for radio licenses.

After Marconi proved that telegraph signals could be sent long distances without the aid of wires there were many noted scientists, experimenters, engineers, and investigators who took a much greater interest in wireless. From 1900 to 1917 we find the names of men like Pickard, Stone, Langmuir, deForest, Kolster, Tesla, Armstrong, Alexanderson, Beverage, Allen, Squire and many others, who achieved distinction in this field. Their efforts were directed mainly towards refinement and improvement in equipment which was in more or less general use at the time.

Marconi's great accomplishment of spanning the Atlantic by wireless in 1901 proved that radio signals could be sent and received over long distances, as we stated before, yet trans-oceanic radio communication did not really become a practical means of communication until the outbreak of the

World War. This was owing to the more or less crude apparatus employed in the earlier days — crude, of course, when compared to that which is found in modern installations.

The American Marconi Wireless Company, in 1903, attempted to establish regular trans-Atlantic communication service from its radio station at Cape Cod, Massachusetts, but the equipment in use was not reliable and, thereafter, the station was used to communicate only with ships at sea. The British Marconi Company maintained a trans-Atlantic station at Glace Bay, Nova Scotia, from 1907 until the World War, but from a commercial viewpoint this station was not considered a success.

From 1901 until the outbreak of the World War most of the activities in radio were confined to marine (sea) service. After the collision between the steamers Florida and Republic, and other marine disasters, the United States Government passed a law that required all passenger ships to carry radio equipment. Marine history is full of records which testify to the value of radio on shipboard, especially when the lives of passengers and crew are in danger. We often read articles that are printed in newspapers and magazines, about imminent or grave disasters to vessels at sea, where radio is referred to as "The Angel of the Deep".

In 1902 the electric arc for radio transmission was developed. The arc system made it possible to convert direct current into high-frequency alternating current and was recognized as a big step forward because this type of transmission generated radio waves which did not cause interference like those generated by other systems. Practically all of the high-power stations employed the arc type transmitter until about 1916, and even today a number of arc stations are still in active operation.

Little did Thomas A. Edison dream of the part he was playing in radio when he was experimenting with his incandescent lamp in 1884. Edison discovered that if a wire was enclosed and sealed inside of an incandescent lamp and the regular filament was heated to incandescence and a battery was suitably arranged with the lamp's elements, an electric current would flow in a direction from the cold wire through the vacuous space inside the lamp and thence to the heated filament, but the current would not flow in the opposite direction. Years passed by before the scientific world used this discovery in a practical way. In 1905 Professor J.A. Fleming of England announced that he had perfected a rectifying "valve" (termed vacuum tube in America) which utilized a circular shaped copper plate placed around the filament. The valve only consisted of two electrodes and, therefore, it became known as a two-electrode valve. He found that the valve possessed the property of altering or converting high-frequency radio currents into currents of considerably lower frequency and, consequently, it could be used for the detection of a radio signal and made to operate the headphones in a receiving circuit. The Fleming valve was used quite extensively as a detector for several years.

A few years later Dr. Lee deForest made one of his greatest contributions to radio when he added a third electrode, called the "grid", to the two-electrode tube. This tube had three electrodes and became known as a "three-electrode tube". The addition of the grid made the vacuum tube hundreds of times more sensitive than any device heretofore used as a detector. Since that time the three-electrode vacuum tube has proven to be

very flexible in operation, which permits it to be used in different kinds of circuits. For example it will function not only as a detector, but as an amplifier oscillator, modulator and so on.

Little use was made of the three-electrode vacuum tube until America entered the World War. As a matter of fact radio up to this period was used only on certain vessels and at a few coastal stations powerful enough to communicate with ships at sea. Even to this day radio's greatest service is at sea; it is always ready to send out the distress call "SOS" and assist in other ways in safeguarding the lives of passengers and crews. An "SOS" has absolute preference over every and all other radio communications.

So we close our brief outline of radio in its second period of development. The third period, from 1917 to the present day, is an era in radio which has never been equalled or surpassed in all history both in scientific and industrial achievements.

IN THE THIRD PERIOD RADIO MADE THE MOST MARVELOUS PROGRESS.

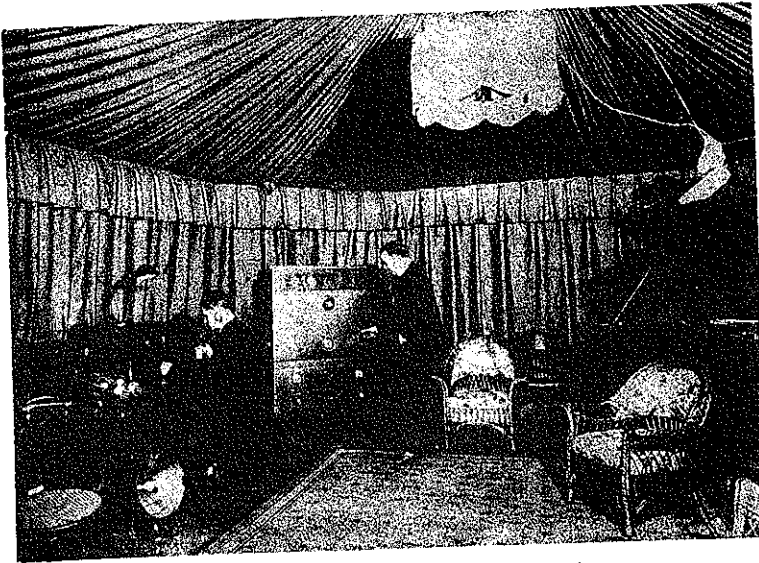
Perhaps the most outstanding development in radio communication during the early stages of the World War was the construction and installation of the first Alexanderson alternator at New Brunswick, New Jersey. This station provided practically continuous and uninterrupted trans-Atlantic service by radio for the first time. Since the war period trans-oceanic radio communication with foreign countries has developed rapidly and more than 10,000 messages are sent and received across the Atlantic and Pacific oceans by radio daily. Trans-oceanic communication is conducted on the long-wave channels by the Alexanderson alternator systems and also by vacuum tube transmitters, and on the short-wave channels by tube transmitters exclusively.

Major Armstrong developed the super-heterodyne receiver during the World War and it was during this period that vacuum tubes really became an important adjunct to radio transmission and reception.

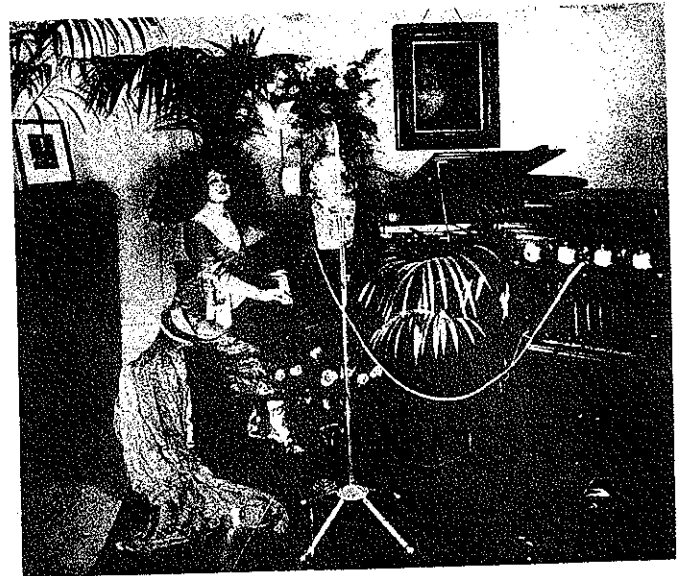
It is not definitely known just how radio broadcasting happened to spring into prominence, or how the idea of broadcasting originated in the minds of Westinghouse Engineers when they first began experimenting with the transmission of voice and music. During the war, however, radiotelephony was successfully employed on ship-board, especially on submarine chasers. Also, schools were established by the U.S. Navy to provide instruction in this new form of communication. Immediately after the armistice was signed, and for several months thereafter, it was not an uncommon thing to have phonograph music broadcasted from a ship equipped with a radio-telephone set and the operators of receiving sets within a range of about 10 miles would "tune in" and listen to the music. This, of course, was done merely to furnish a little entertainment. There is every reason to believe that these post-war demonstrations of radio may have had considerable to do with the birth of present-day broadcasting.

The leaders of American industry must have visualized a brilliant future for radio in 1918, or two years before actual broadcasting. Plans were made to form an all-American organization in order to utilize radio to its best advantage and thereupon, in 1919, the Radio Corporation of America came into existence. When this corporation was formed it obtained all of the rights

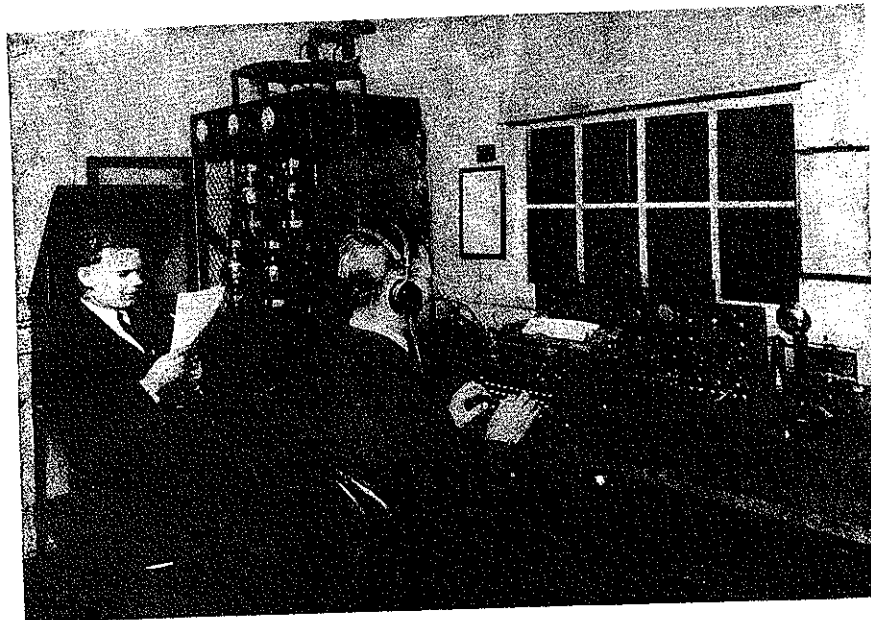
The Last Word in Broadcasting Equipment in 1921.



The old WDY station with the studio transmitter, transmitter and receiving equipment all quartered in one room.



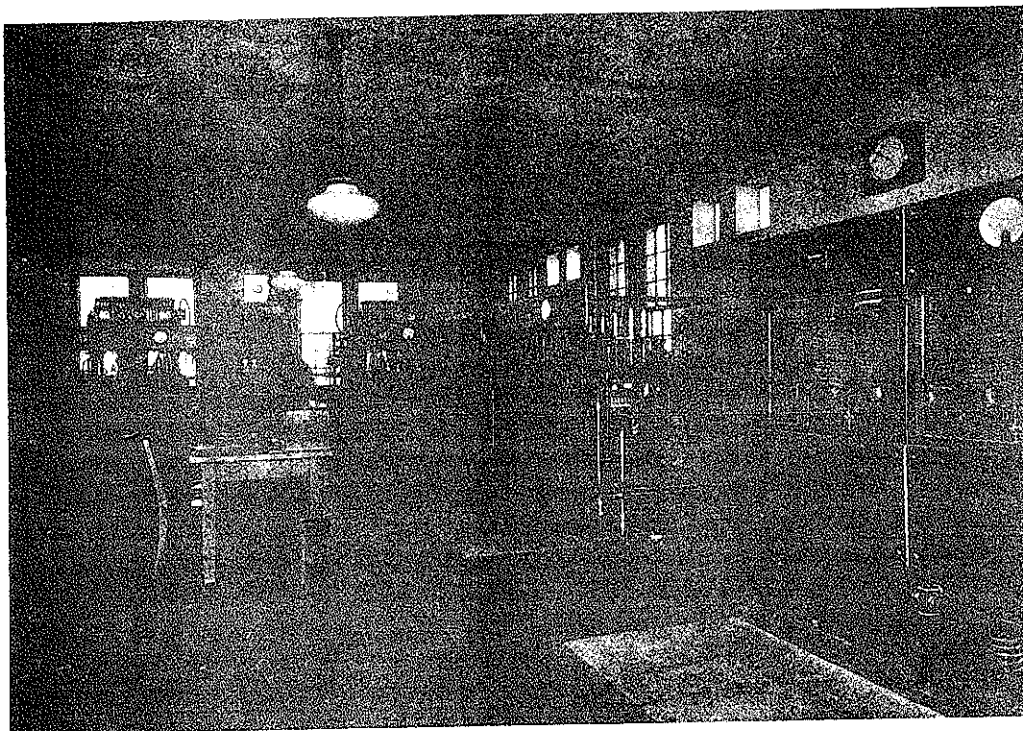
Olga Petrova formally opening WJZ, then located at Newark, N.J.



The operating room of WJZ's old station at Newark, N.J. with the transmitter, at the left, consisting of three modulator tubes and two oscillator tubes.

Note: Compare these photographs with those on the following page.

Broadcast Equipment of 1930. The Studios of both WJZ and WEA^F are on Fifth Avenue, New York City.



The transmitting room of WJZ located at Bound Brook, N.J.



The transmitting room of WEA^F located at Bellmore, N.Y.

of the American Marconi Wireless Telegraph Company. When it was joined later by the General Electric Company and other engineering concerns there was welded together, into one central organization, the principal radio inventions and radio research facilities of America.

All of us remember the radio craze of 1920 and 1921. At that time small battery operated regenerative receiving sets, consisting of a detector and two stages of audio-frequency amplification, sold at prices up to \$150 without tubes. The ordinary 201 type vacuum tube sold for \$9, and it was a difficult matter to obtain either receivers or tubes because the demand was greater than the supply.

Station KDKA started broadcasting on November 2, 1920, by giving the presidential election returns of the Harding-Cox campaign and in less than three years after that day there were more than 500 broadcasting stations in operation in the United States.

In 1920 the retail value of receiving sets, tubes and parts, amounted to less than two million dollars as compared to approximately one billion dollars in 1929. In other words, in business proportions the radio industry increased five hundred times in a period of nine years. Just think for a moment what a stupendous amount of money that is, and that the greatest part of this growth occurred since 1927, in just only a few years!

Reliable statistics show that there were approximately six million radio receiving sets in use at the beginning of 1927, whereas, there were more than fourteen million sets in use at the beginning of 1930.

Approximately thirty million vacuum tubes were sold in 1927, over sixty million in 1928, and more than one hundred million in 1929.

In 1920 there was only one radio broadcasting station in the United States, but in 1929 there were more than 700.

A vast army of men are now employed in the radio field as compared to the mere handful prior to the year 1920. In America the radio industry has grown so large that it now employs almost half a million workers, supports approximately thirty thousand retail stores, and keeps more than a thousand factories in operation.

It may be surprizing to note that nothing really new has been developed in the radio industry since the World War. The later developments have been, for the most part, in the refinement of apparatus used prior to and during the World War.

We must, however, make exceptions to the above statement in a few cases. One is concerning the photoradiogram apparatus developed by Major R.H. Ranger for the transmission of a copy or a reproduction of a document, drawing or picture. This is called facsimile or picture transmission by the photoradio method. Another exception is television, but this new art is still in the laboratory stage and will probably not become a commercial proposition for several more years, according to the opinions of leading engineers.

We are often asked the question, "What are the limitations in radio?" We

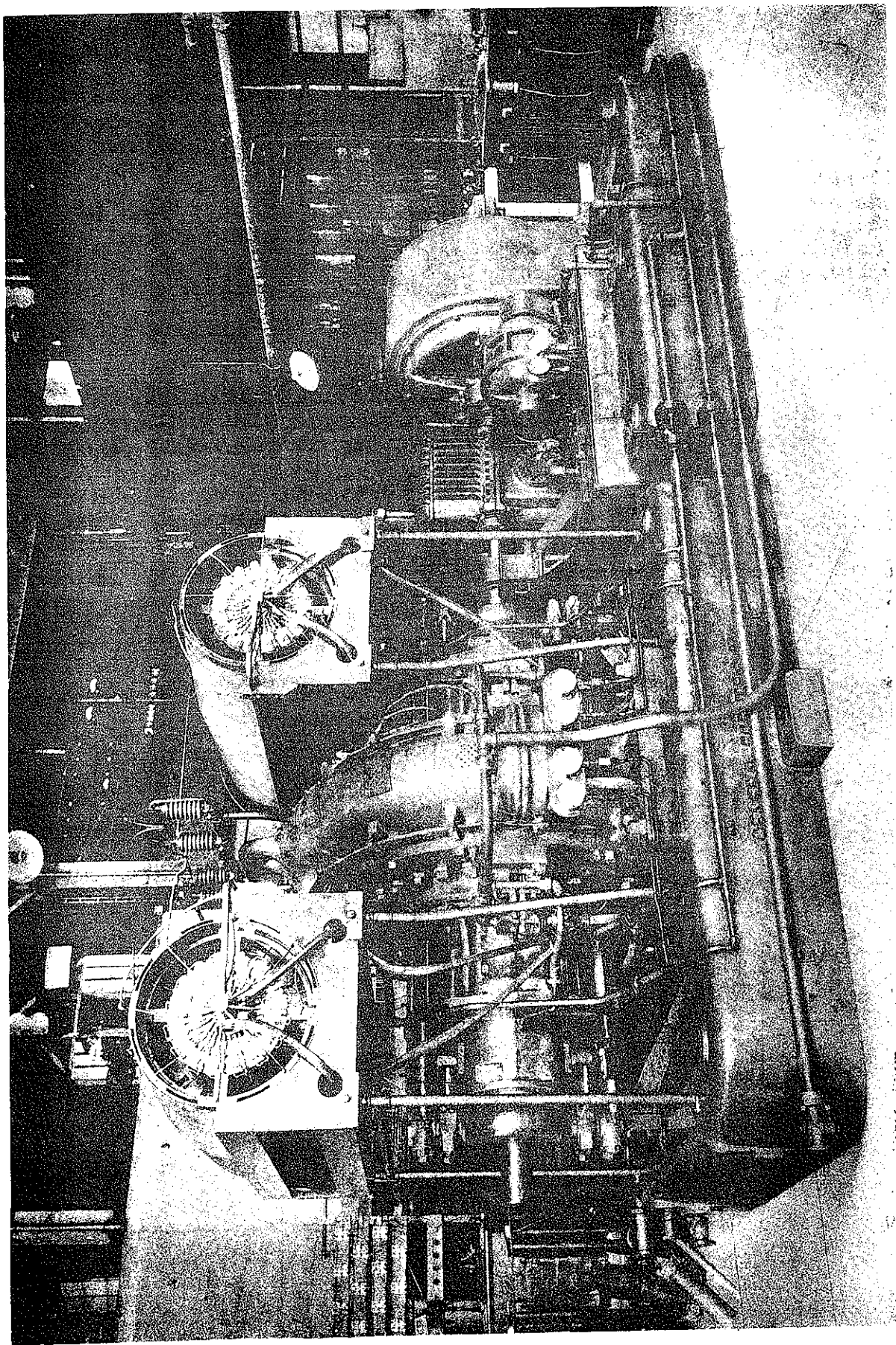
might answer this question by saying that there are apparently no limitations. Radio today is used chiefly for broadcasting, for trans-oceanic communication (both telegraph and telephone) and on ship-board. But railroads, mining and oil companies, and in fact many industries are now experimenting with radio. Radio channels are now allocated by the U.S. Government Radio Commission for rendering domestic telegraphic service via radio and the commercial companies are busy getting this new service into practical operation. And finally, when television and picture transmission become an actuality, radio will enter a period of activity comparable only to the days when radio equipment could not be purchased at any price. Radio is no longer an infant — it is a colossal giant. But the field is young and presents unlimited opportunity for those who want to grow with it.

In the foregoing paragraphs we have given you a snap-shot picture of the development of radio. We have considered the subject only from the viewpoint of its history so that it may be shown that radio has actually required hundreds of years to reach its present position where it has become one of the world's leading industries. If you inform yourself about most of the worth-while things with which our world is blessed, you will find that it has taken years and years of diligent research and hard work on the part of many individuals before the stage was reached where the particular article or thing we have in mind was ready for use by the general public. This applies just the same in the case of radio, automobiles, telephones, electric lighting, and so on.

Before proceeding with our studies let us clear up this one question: "What is the difference between radio and wireless?" The term "wireless" is derived from the fact that communication may be effected between two points without the aid of wires connecting the points and the term "radio" is derived from the fact that the electrical energy released into space is radiated in all directions. Wireless and radio, therefore, mean one and the same thing. Uninformed persons often associate "wireless" with the transmission of the radiotelegraphic code, and "radio" with broadcasting. In the United States the term "radio" has become recognized as the only expression to use whenever referring to any kind of communication effected without the use of wires. In certain foreign countries, the term "wireless" is still in vogue when reference is made to the use of radio on shipboard.

HOW TO GET THE MOST OUT OF YOUR STUDIES.

This course of radio instruction has been prepared for students who do not have access to laboratories and laboratory equipment. Throughout the course considerable theoretical discussion is presented together with numerous problems of a practical nature, all supplemented with sufficient notes to make each step clear. The purpose of the course is to treat the subject from beginning to end in a thoroughly practical manner so as to give the student a sound working knowledge of this subject. The student who honestly applies himself and really studies this course will, at its completion, find himself in possession of radio knowledge far above the average. Before beginning your studies convince yourself that you are going to master the subject and in this way you will rid your mind forever of any doubt as to whether or not you can obtain a knowledge of radio by Home Study Instruction. If you have an earnest desire to make satisfactory progress you will win; on the other hand, if you are the kind that becomes easily discouraged when something more or less difficult is given you to do then you can not hope to



The giant Alexanderson alternators used in trans-oceanic telegraph service for long-wave transmission.

succeed. Of course, we assume that most everyone having the ambition to start a course of study will follow it through to the very end.

Naturally, to learn about a subject of wide scope requires effort — if it did not, it would be of little or no value to you. Anything that is as easy as A-B-C is too easy to be of practical value. The first few lessons in our course are comparatively simple because the subjects treated are quite general to give you a good background. You will find as you proceed to the more advanced work that it will require a certain amount of time and thought on your part to get everything out of a lesson that it contains. But remember one thing — Home Study instruction is practical. This is substantiated by the fact that fully half of our universities and the United States Government are conducting courses by the Home Study Method. Here is a letter that one of our students wrote a few months ago:

"I could not understand how in the world one could learn, on paper, about things that required actual practice. However, just to prove to myself that this could not be done, I decided to try your course.

But as I went along with the lessons I became more and more interested. Up to the present I have covered lessons 33 and 34, and I would not now give up the course for five times the tuition paid.

The proof of the pudding is in the eating. If ever a man can invest the cost of the tuition fee in a Home Study course to better advantage and get more for his money than I have, I wish he would let me in on it".

Just how and when you should study depends upon conditions over which we here in the school have no control. One often finds that he can do real intensive studying early in the morning, before the regular day's work begins, and for a time in the evening after the day's work. Many of our students declare that they can concentrate better at those particular periods of the day.

You may be certain of one thing — you cannot justify your study periods when you are "wool-gathering". If your mind is on the swimmin' hole then go swimming and get it over with. You must concentrate on your work if you expect it to mean much to you. Lay out a definite program for study and stick religiously to it. Do not be misled by any thoughts that your friends will forsake you because you hibernate for a few months; quite the contrary, they will admire you when they learn of your success. And if you can and will apply a goodly amount of stick-to-itiveness for a few months you will make surprisingly fast headway.

Addison remarked: "Knowledge is that which truly and essentially raises one man above another". This proverb was true a hundred years ago and in this day and age of specialization it is more true than ever.

We all have our little ups and downs — our high periods and our low periods. The absolutely perfect man has yet to be developed, hence, we must not be discouraged because our mind does not behave for us at all times when we want to concentrate.

One of our students recently said: "I know good and well that I have days when I can accomplish a week's work, and then again there are occasions when it takes me a week to do a day's work."

Remember that ambition, persistence, dogged perseverance, determination, and last but not least, concentration— these characteristics in a man will enable him to surmount the biggest obstacles. The foregoing sentence should be your slogan in life.

Statistics state that fully ninety per cent of the people in the world are satisfied with their surroundings and what they own; at least they seem to be satisfied to the extent that they make no effort to improve existing conditions. Think of it! It is no wonder that there has always been and always will be more \$50,000 a year jobs than there are qualified persons to fill them. You, no doubt, know of many individuals who aspire only to positions of routine work and who will never, as long as they live, be able to have the nicer things in life. They lack ambition and the other qualities mentioned above.

Some Suggestions on Practical Studying.

Now to return to this question of when and how to study. If we advise you when and how to study, will it be helpful to you in any way? Let us answer this question for you by giving you the opinion and advise of the President of our school who has toiled through a long experience of study and business activity. He says: "I really had to learn how to study. During and since the World War my efforts have been devoted wholly to the subject of radio instruction which required intensive study and research to keep abreast of developments. I would not undertake studying during the business hours of the day because of the many disturbances that constantly break my line of thought and reasoning. So I confine myself in closed quarters at least five nights each week until eleven o'clock — rarely later than midnight. I maintain this schedule from October until May starting about 7:30 each evening, and during my study period I will not tolerate interruptions. My business day is over when I begin my personal study work and business waits until the next day. I would not answer a telephone call, or a knock on the door, from anyone except in the case of sickness or emergency of any kind. As a matter of fact I isolate myself from people and telephones. I am not available to anyone when I study."

"By devoting five evenings each week (from October until May) to study I still have two evenings each week for pleasure, and I play just as hard as I study. These two evenings enable me to see my friends and chase the bugaboo that "all work and no play makes Jack a dull boy". But, on the other hand, "all play and no work certainly won't make Jack a bright boy". During the months of June, July, August and September I endeavor to study about one or two hours every morning before my regular business day begins. It is difficult for me to apply myself diligently in the evening after the day's work especially during the extremely warm weather, but I partly make up for this by the morning study period."

"Your daily working hours may differ from mine, but you can make some adjustment in your schedule to permit you to find time for study. Of course, we all have our "off" days when we do not feel right — perhaps it is a

slight illness or some other distracting element that handicaps us. At other times we may become tired and it is then that we should relax for a few moments — take a short brisk walk in the open air, but do not quit. Obtain eight or nine hours sleep each night and even if you do get tired, no harm is done".

We want you to remember that we are here to help you, but before you request help from us about certain parts of your lessons that may prove somewhat hard, make every effort to overcome the obstacle yourself. Do your level best in this matter because if you are able to conquer the difficulties alone you actually jump several steps forward in your personal development. We want you to feel that you have formed a partnership with us and that it requires hard work on the part of us all to achieve genuine success. There is no exception to this rule.

In our years of teaching we occasionally come in contact with students who have exclaimed, "I want to learn radio — not electricity". It is as impossible to learn radio thoroughly without some study of electricity as it would be to learn how to read and write without knowing the alphabet. Although this is not an electrical course, yet it is absolutely essential that you must learn the fundamentals of electricity as taught in the first few lessons to understand radio. You will agree with us on this point after you have made some headway with the instruction.